NCP3-E42 **PATENT APPLICATION**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Examiner: R. Krishnamurthy
NOR-CAL PRODUCTS, INC.	Group Art Unit: 3753
Serial No.: 09/738,194	
Filed: 12/15/2000	November 14, 2002
For: IMPROVED PRESSURE CONTROLLER AND METHOD	San Diego, California 92108

DECLARATION OF Per M. Cederstav

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

I, Per M. Cederstav, declare that:

1. We are the inventors of the invention that is the subject of the instant application for patent;
2. I was asked by Karl M. Steins to prepare a letter regarding the nature of the problems solved by my invention; and
3. Attached hereto is a true and correct copy of the letter which I prepared in support of this Patent Application.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 19 of the United States Code, and such willful false statements may jeopardize the above-identified Application and any patent issuing therefrom.

Signed at San Diego, CA By: Per M Ced

on this day of November 14, 2002 Print Name: Per M. Cederstav

November 14, 2002

To Whom It May Concern:

Subject: Our Invention that is the subject of U.S. Patent Application No. 09/738,194

Background and Qualifications

I am an expert in the field of high purity gas systems generally, including downstream pressure control, specifically. I was granted a BS in Chemical Engineering in 1988, and have been deeply involved in high purity gas delivery and control systems in and around the semiconductor industry since 1993. I published papers on downstream pressure control technology in 2000, 2001 and 2002.

I have been aware of the limitations, problems and technological developments in the field of Downstream and Upstream Pressure Control environments for several years. I have been aware of particular limitations and problems that have plagued the Vacuum Processing Industry, including but not limited to the Semiconductor, Industrial Coating and the R&D Community in support of these industry segments, namely:

(1) the fill-time required to reach the target pressure in the process (vacuum) chamber, with the emphasis on it needing to be shorter in order to increase throughput;
(2) the precision of pressure control at the target pressure, since real-time stability and run-to-run repeatability directly affect the quality and yield of the materials being vacuum processed;
(3) the challenge of achieving the same quality of pressure control in a variety of vacuum process conditions, to the extent that traditional PID parameters have to be uniquely defined for each step in the process, resulting in time consuming "tuning";
(4) the responsiveness of the control system to compensate for instantaneous changes in the process environment including, but not limited to, flow changes and plasma strikes. Unresponsive systems cause unpredictable and non-repeatable pressure fluctuations that affect material yields;
(5) the need for unnecessarily complex of valve drive design, adding gear or belt reducers to increase positional resolution and adding limit switches to detect critical positions of the valve. Such additional design requirements increase the cost of the valve and valve drive manufacturing and maintenance.

Solution to Problems

Our technology and associated valve designs significantly improves, and sometimes completely eliminates, all of these issues and problems through the use of High Performance, Closed Loop Motion Control. Prior to our invention no other design in the Downstream or Upstream Pressure Control environments included the use of High Performance, Closed Loop Motion Control.

With closed loop motion control, valve open and closed limit switches (requiring assembly and adjustment time) and associated hardware and circuitry have been eliminated.

Expensive motor reducers (ex. gear heads and belt drives) can now be eliminated from certain valve types, simplifying the design and lowering the cost of manufacture. Furthermore, preventive maintenance intervals can be extended due to diagnostic intelligence of the closed loop motion control system. Speed of valve actuation and positioning precision has been increased many times. All of these improvements have resulted in robustness of motion and pressure control never possible before.

Distinction from "State of the Art"

The following are the relevant manufacturers in the field of our invention. Based upon my prolonged knowledge of the field of this invention, it is my belief that the chart below represents all relevant manufacturers and their products (including those from Nor-Cal Products), and that no pertinent devices or manufacturers have been omitted.

Manufacturer	Throttling Valve Product Type	Model	Motor	Gear / Belt & Pulley	Position Feedback	Motor Control Technology	Time open to closed	# Steps of Resolution
BOC Edwards	Butterfly Valve	1850-series	Unknown	Unknown	Open and Closed limit switches, only. Type unknown	Open Loop	0.3 sec	Unknown
MelVac	Radial Vane Valve	CVQ-Series	6-wire, Bi-polar, 15° / step, variable reluctance, disk rotor	Gear @ 25:1	Open and Closed mini mechanical switches, only	Open Loop	8 sec	1,152
MKS Instruments	Butterfly Valve w/integral controller	153-series	6-wire, Bi-polar, 15° / step, variable reluctance, disk rotor	Gear @ 25:1	Open and Closed mini mechanical switches, only	Open Loop	8 sec	1,152
	Butterfly Valve	253-series	6-wire, Bi-polar, 15° / step, variable reluctance, disk rotor	Gear @ 25:1	Open and Closed mini mechanical switches, only	Open Loop	8 sec	1,152
	Butterfly Valve	653-series	6-wire, Bi-polar, 1.8° / step hybrid stepper	Gear @ 30:1	Open and Closed mini mechanical switches, only	Open Loop	2 sec	3,000
	Butterfly Valve w/integral controller	683-series	6-wire, Bi-polar, 1.8° / step hybrid stepper	Gear @ 30:1	Open and Closed mini mechanical switches, only	Open Loop	2 sec	3,000

Mykrolls Corporation	Butterfly Valve	MDV-series	6-wire, Bi-polar, 1.8° / step hybrid stepper	Belt & Pulley @ 16:1	Open and Closed optical switches. Potentiometer position feedback for monitoring, only	Open Loop	1.8 sec	1,600
	Butterfly Valve	MDVX-series	6-wire, Bi-polar, 1.8° / step hybrid stepper	Belt & Pulley @ 16:1	Open and Closed optical switches, only	Open Loop	1.8 sec	1,600
VAT Vakuumventile	Butterfly Valve	Series 61	Unknown	Unknown	Open and Closed limit switches, only. Type unknown	Open Loop	Unknown	Unknown
	Gate Valve	Series 64	Unknown	Unknown	Open and Closed limit switches, only. Type unknown	Open Loop	Unknown	Unknown
	Pendulum Valve	Series 65	6-wire, Bi-polar, 1.8° / step hybrid stepper	Gear @ 16:1	Open and Closed optical switches, only	Open Loop	2-3 sec	1,600
Applied Materials	Butterfly and Vane Valves	N/A	6-wire, Bi-polar, 1.8° / step hybrid stepper	Belt & Pulley @ 16:1	Open and Closed optical switches, only	Open Loop	~2 sec	1,600
Nor-Cal Products	Butterly Valves	TBV-series	6-wire, Bi-polar, 1.8° / step hybrid stepper	None, i.e. 1:1	Back EMF motor position signals throughout stroke	Closed Loop	125 msec	102,400
	Geared Butterfly Valves	TBVG-series	6-wire, Bi-polar, 1.8° / step hybrid stepper	Gear @ 15:1	Back EMF motor position signals throughout stroke	Closed Loop	250 msec	1,536,000
	Pendulum Valves	TPV-series	6-wire, Bi-polar, 1.8° / step hybrid stepper	5mm pitch Ball-screw	Back EMF motor position signals throughout stroke	Closed Loop	2-4 sec	8,000,000 to 20,000,000 depending on valve size

Per Cederstav

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DECLARATION OF David Kruse

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

I, David Kruse, declare that:

1. We are the inventors of the invention that is the subject of the instant application for patent;
2. I was asked by Karl M. Steins to prepare a letter regarding the nature of the problems solved by my invention; and
3. Attached hereto is a true and correct copy of the letter which I prepared in support of this Patent Application.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 19 of the United States Code, and such willful false statements may jeopardize the above-identified Application and any patent issuing therefrom.

Signed at San Diego, CA By: David Kruse

on this day of November 14, 2002 Print Name: David Kruse.

November 14, 2002

To Whom It May Concern:

Subject: Our Invention that is the subject of U.S. Patent Application No. 09/738,194

Background and Qualifications

I am an expert in the field of Control Systems Utilizing Motion Control, I was granted a BS in Electrical Engineering in 1972, and have been deeply involved in Motor and motion control hardware and software design since 1968. I have been aware of the limitations, problems and technological developments in the field of Pressure Control in High Vacuum environments for several years. I have been aware of particular limitations and problems that have plagued the science of Pressure Control in High Vacuum environments, namely

(1) time to pressure set point;
(2) precision of control to pressure set point;
(3) difficulty adapting pressure control to a broad range of environmental conditions;
(4) responsiveness in correcting for instantaneous changes in the environment;
(5) complexity of valve drive design;
(6) cost of maintenance; and
(7) cost of manufacturing.

Solution to Problems

As the degree of these limitations is mostly relative, our design significantly improves, or altogether eliminates, all of these long-felt limitations and problems by the use of High Performance, Closed Loop, Motion Control. Prior to our invention, no other Pressure Control in High Vacuum environments design included High Performance, Closed Loop, Motion Control.

With closed loop motion control, valve open and closed limit switches (requiring assembly and adjustment time) and associated hardware and circuitry have been eliminated. Expensive motion reducers (gear heads) have been eliminated from Throttling Butterfly valves. Preventive maintenance schedules can be more conservative (or completely eliminated) due to diagnostic intelligence of the closed loop motion control system. Speed of valve actuation and precision of positioning is increased many times – this robustness of motion control greatly simplifying and optimizing the end goal of Pressure Control.

Distinction from the References

In his office action, the Examiner has expressed the opinion that the *Fitzgerald* patent discloses an invention that is indistinct (from a patentability standpoint) from our invention. I would have provided the following technical discussion to substantiate my position:

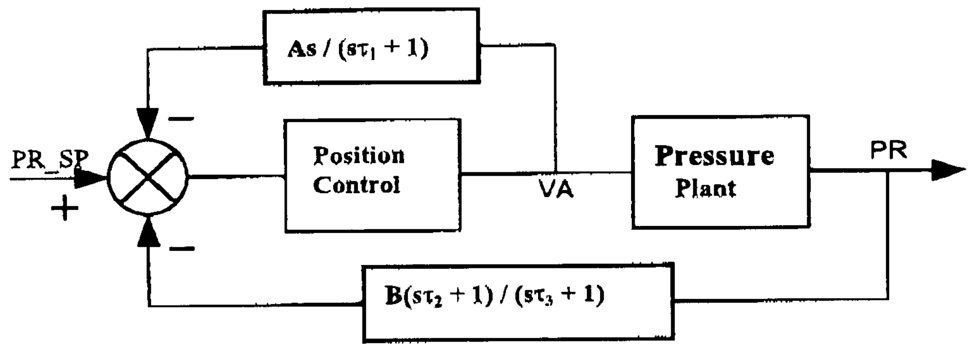
The Fitzgerald patent (issued June 22, 1971) is the examiner's primary argument for rejection of all claims in our Method Patent. In this patent, the inner (motor) feedback loop is responsive **only** to a ***change in*** **motor position** (not position) as described in lines 14 through 25 of column 4 (variable decay circuit 26). This is **entirely** in keeping with the intent of the patent, which is to **slow down** the response of the motor to rapid pressure set-point changes for the **sole purpose of eliminating hunting** (ref. Abstract, etc). The issue of "hunting" resulting from large delays in pressure signal is a problem with which we also must contend, but it is not the one we're addressing with our patent. It should be noted that the contemporary solution to pressure signal delays is to retard valve movement with the use of a Proportional *plus Derivative* **Pressure** control algorithm. While use of a damping (change in motor position) component of motor feedback is commonplace in all high performance motion control servo systems, the way the Fitzgerald circuit is constructed the feedback affords **only speed control**, and **not position control**. Therefore, it is not a *high performance* positioning system, which our patent teaches. Contrary to Fitzgerald, our system **strives to achieve** high speed, high resolution motor positioning. Thus, while the field of Fitzgerald's patent is pressure control in high vacuum environments such as ours, it does not have the same objective in mind, and so, does not employ the same methodology in achieving that objective. As noted in our Figure 9, a true high performance positioning system experiences **excessive valve movement** intentionally for the purpose of speeding up the pressure response. We clearly demonstrate in our Figure 9 what we're calling **improved pressure control** in our claims by use of *high performance* motor positioning.

In Fitzgerald's Abstract he states "... position feedback signal from the valve prevents the valve from being moved past the equilibrium position to reduce 'hunting.'" Paraphrasing, "...motor response is retarded."

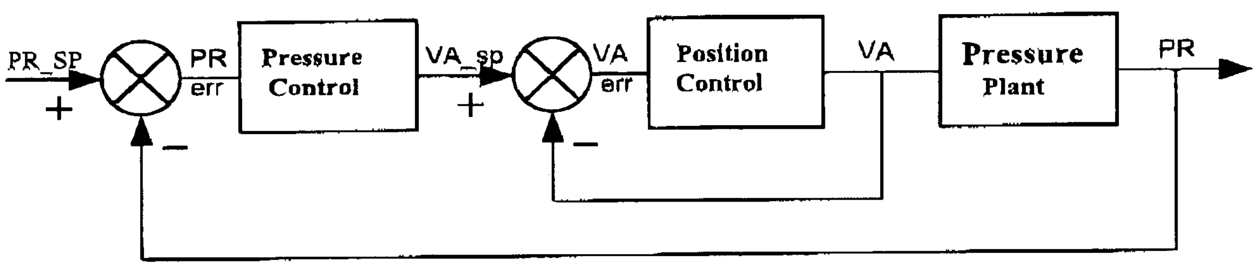
Fitzgerald's use of the phrase 'position feedback' is rather liberal in that the feedback signal generated by the **position** transducer 24 is modified by the **variable decay circuit** 26 before being applied to the error node 12, changing the feedback from one of position to velocity, otherwise called damping. Our valve angle set point defines a position to which the motor is commanded. Since our controlled variable (feedback) is motor **position**, we can accomplish that command with a high degree of precision (Fitzgerald could not). As our patent

teaches, it is precisely this closed loop **position** control which affords us high performance pressure control.

Please see the comparison below:



Fitzgerald Pressure Control: The block diagram shown here depicts the function of Fitzgerald's Figure 1. Note the derivative term (s) in the motor Position (VA) feedback branch; that is, the controlled variable is velocity, not position. However, this single-node summing junction also receives Pressure feedback (PR), with lead-lag compensation. This single-node, double-loop servo system works with velocity control because at steady state (zero velocity) the output of the summing junction is Pressure Error (unambiguous). This solution does not work with position as the controlled variable, because steady-state position is not necessarily zero, resulting in non-zero Pressure Error.



High Performance Pressure Control Circuit Topology: The inner (Independent) valve position control loop influences pressure control performance by responding to a position command (VA_sp) from the Pressure Controller quickly and precisely. To accomplish this performance the controlled variable must be Valve Position (VA). The task of compensating for Pressure anomalies (such as delays) should be that of the Pressure Control algorithm. A slow valve position response only complicates the task of the pressure controller. Note that the error signal operated on by the Pressure Controller is unambiguous. Each of the two controllers in this topology is afforded algorithm flexibility. That is, the Position Control algorithm can include a derivative term for damping the response and an integral term for zeroing position error. This, while the Pressure Control algorithm contains its own performance optimization algorithm, including damping and possibly other higher order terms.

David Kruse